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ICHTHYOLOGY.—*A key to the species and subspecies of the cyprinodont genus Fundulus in the United States and Canada east of the continental divide.* JERRAM L. BROWN, Cornell University. (Communicated by EDWARD C. RANEY.)

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There has not been a complete, reliable guide for the identification of the species and subspecies of the fishes of the genus *Fundulus*. The genus is found in more than half of the United States, in southeastern Canada, Bermuda, northern Cuba, and certain coastal areas of Mexico. Only in the United States and Canada east of the Continental Divide, the area covered by this key, and in Mexico (?) do two or more species occur sympatrically, so far as known.

Of the 33 currently recognized species and subspecies, 7 do not occur in the area covered by this key. Two of these, *Fundulus grandissimus* Hubbs (1936: 209) and *Fundulus persimilis* Miller (1955: 13), have been collected only in the Mexican state of Yucatán. Two are insular subspecies, *Fundulus heteroclitus bermudae* of Bermuda and *Fundulus grandis saguanus* Rivas (1948) of the north coast of Cuba. The remaining three are allopatric on the Pacific coast. They are *Fundulus p. parvipinnis* from Morro Bay, Calif., south along the coast to the area occupied by the next form; *F. p. brevis* in Magdalena Bay, Baja California; and *Fundulus lima* in fresh-water springs at San Ignacio, Baja California. All but one of these 7 forms are related to *Fundulus heteroclitus* and *F. grandis*. *Fundulus persimilis* is closest to *F. similis*.

The center of speciation may have been in the southeastern United States, where 20 species are now found. *Fundulus* occurs in habitats ranging from salt marshes and the ocean to upland streams, but it is usually found in relatively quiet water.

I wish to thank Dr. Edward C. Raney for his generous assistance and encouragement in this study. The work was completed at Cornell University in 1954 as a master's thesis, which may be consulted in the Cornell University Library for additional details.

MATERIALS AND METHODS

This study was based on counts and measurements made on over 1,500 specimens in the Cornell University fish collection. In addition, 31 specimens of *Fundulus notti dispar* were examined on loan from the University of Michigan Museum of Zoology, for which I thank the curator, Dr. Reeve M. Bailey.

External characters have been used exclusively. The descriptions of coloration are based entirely on preserved specimens. For a few species counts were taken from published accounts by authors who used the methods of counting described by Hubbs and Lagler (1947). These instances have been acknowledged in the key in order to remind the reader of the differences in the methods of counting used by these authors, which result in one fewer ray in the dorsal and anal fins and from one to several more scales in the lateral line. Numbers in parentheses in the text of the key represent the known range or extreme values not often encountered. It is frequently necessary to know the sex of a specimen since all of the species show some degree of sexual dimorphism. This can be determined in the adults of all species by the presence of a pouch covering the anterior base of the anal fin of females and by its absence in males. The pouch carries the ovi-

duct down the first ray of the anal fin and is of various degrees of prominence depending on the species. For some species the key is based on a relatively small number of specimens; consequently, some specimens which do not fit the descriptions exactly will undoubtedly be discovered.

Dorsal, anal, and pectoral rays were counted at their bases; the last two rays were not counted as one. *Lateral-line scales* were counted according to the method of Hubbs and Lagler (1947: 11) except that the most anterior scale counted was the one in which the center of the exposed field of the scale lay exactly on, or just posterior to, a vertical line through the upper extremity of the gill slit. *Scales around the caudal peduncle* (often, but not necessarily, the least count) were counted vertically half way between the posterior bases of the dorsal and anal fins and the anterior limits of the upper and lower procurrent caudal rays. *Scales above the lateral line* were counted in front of the dorsal fin from the first scale above the lateral line of one side, in a vertical row, to and including the last scale above the lateral line of the other side. *Mandibular pores* correspond to pores W, X, Y, and Z of Gosline (1949: pl. 2). Most species of *Fundulus* have four on each side.

Head length was measured with dividers from the bony opercle at its most posterior projection to the tip of the snout, with the mouth in its normal closed position. *Snout length* was taken on the midline from the tip of the snout to the anterior bony rim of the orbit, with the point of the dividers inserted to the bony interorbital septum. *Postorbital head length* was measured from the posterior fleshy rim of the orbit to the posterior edge of the bony opercle at a level with the upper base of the pectoral fin. The *orbit* was measured horizontally with dividers between the fleshy rims of the orbit. Other measurements and counts were made according to the methods of Hubbs and Lagler (1947: 8-15).

KEY TO THE SPECIES AND SUBSPECIES OF FUNDULUS
IN THE UNITED STATES AND CANADA EAST OF
THE CONTINENTAL DIVIDE

1. Gill slit restricted; upper end of gill slit opposite or only slightly above upper base of pectoral fin, relatively far from posterodorsal corner of opercle.....2

- Gill slit normal, not restricted; upper end of gill slit relatively far above upper base of pectoral fin, at or anterior to posterodorsal corner of opercle.....5
2. (1) Vertical bars absent in both sexes; D. 13-16; A. 13-19.....20
Vertical bars present in both sexes except in females of *F. luciae*, for which D. 8; A. 10 3
 3. (2) Dorsal rays 8; anal rays 10; lateral-line scales 31-32; smallest species of *Fundulus*; females plain; males vertically barred and with a black ocellus on last few rays of dorsal fin; dorsal over anal in females, behind in males; Atlantic coast, North Carolina to Long Island..... *F. luciae*
Dorsal rays 11 or more; anal rays 13 or more; lateral-line scales 41-64 (Hubbs, 1926: 15); dorsal in advance of anal; 11-21 vertical bars 4
 4. (3) Lateral-line scales 52-64 (Hubbs, 1926: 15); dorsal rays 15-17; anal rays 15-16; Wyoming and South Dakota to northern Texas and New Mexico.....*F. kansae*
Lateral-line scales 41-49; body more robust; eye larger (Hubbs, 1926: 15); upper Brazos, Colorado, and Pecos drainages of Texas and New Mexico and the Llano Estacado of northwestern Texas..... *F. zebrinus*
 5. (1) Dorsal rays 9 or less.....6
Dorsal rays 10 or more.....14
 6. (5) Anterior insertion of dorsal behind (or over) anterior insertion of anal; dorsal rays fewer than anal rays.....7
Anterior insertion of dorsal before or over anal; dorsal rays more than or equal to anal rays.....14
 7. (6) Lateral, longitudinal band single, median, broad (several scale rows in width), brown or black, extending from tip of snout and chin through eye to base of tail; D. 8-12; A. 11-13; pectoral 14 to 15; lateral-line scales 32 to 36.....8
Lateral, longitudinal bands either absent or several (about 5-9), each the width of one scale row or less, not extending onto head 9
 8. (7, 14) Spots on sides of back conspicuous, discrete, black; lateral band of females even-edged; vertical bars in males not prominent; spots on vertical fins irregular in size, shape, and distribution, often very small, like finely ground pepper; young conspicuously black about base of anal fin
F. olivaceus
Spots on sides of back inconspicuous, diffuse, olive-brown; lateral band of females strongly serrated; vertical bars in males prominent, sometimes disrupting the longitudinal band; spots on vertical fins large, often arranged in rows; very fine spots often absent; young with pigment about anal fin brownish and inconspicuous.....*F. notatus*
 9. (7) Blackish subocular blotch present on

- cheek; caudal fin oboval, almost pointed; about 5-9 lateral, longitudinal, dark lines in females (except in *F. n. notti*); vertical bars strong in males. *F. notti* 10
- Blackish subocular blotch absent; cheek lighter than rest of head; caudal fin square or round; no lateral, longitudinal dark lines on either sex; vertical bars usually not strong. 12
10. (9) Scales around caudal peduncle 16-17 (16-19); Ochlockonee River of western Florida eastward and northward in Atlantic coast drainages to southern Virginia
F. notti lineolatus
Scales around caudal peduncle 20 (18-20) . . . 11
11. (10) Anal rays usually 10; dark, longitudinal lines of females not outstanding; light rows between them crossed by the dark edge of each scale; in large females all body coloration virtually absent except the dark spots in the scale centers; Gulf coast drainages from New River of western Florida to Texas
F. notti notti
Anal rays usually 11; dark longitudinal lines of females prominent; light rows between them virtually clear; Mississippi Valley
F. notti dispar
12. (9) Sides of body with 12-30 round spots the size of a scale or less, often arranged in two rows lying along or above the lateral line, blended in some specimens to form short, indistinct, vertical bars; scales around caudal peduncle usually 16; top of head flat or slightly concave in front of eyes; snout sharp. *F. jenkinsi*
- Sides of body rarely spotted; if so, spots in the nature of dense, black irregular blotches randomly scattered over body and fins; vertical bars distinct in most males, absent in females (except *F. cingulatus*); scales around caudal peduncle usually 20; top of head flat or slightly convex in front of eyes 13
13. (12) Total mandibular pores 6; scales above lateral line 9 (8-11); dorsal rays 8 (7-9); anal rays 10 (11); lateral-line scales 29-30 (28-33); snout short and rounded, length 1.6-2.2 into postorbital head length; anal fin of adult males usually longer than head; small, light, "pearl" spots on sides of body absent; vertical bars on sides of males and females narrow, straight, with distinct edges, usually 12 or more. *F. cingulatus*
- Total mandibular pores 8; scales above lateral line 10-11 (9-12); dorsal rays 9 (8-10); anal rays 11 (10-12); lateral-line scales 31-33 (30-34); snout longer and more pointed, length 1.4-1.7 into postorbital head length; anal fin of adult males usually shorter than head; small, light, "pearl" spots present in females, irregularly scattered over sides of body; vertical bars on sides of males wider, often wavy and irregular, edges often indistinct, usually less than 12. *F. chrysotus*
14. (5, 6) Lateral, longitudinal band single, median, broad (several scale rows in width), brown or black, extending from tip of snout and chin through eye to base of tail; D. 8-12; A. 11-13; pectoral 14 to 15; lateral-line scales 32-36. 8
- Lateral, longitudinal bands, if present, not extending onto head or snout, often more than one. 15
15. (14) Lateral-line scales 40 or more; or if less (as sometimes in *F. diaphanus*) caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.4 or more, a slender species with vertical bars in both sexes. 16
- Lateral-line scales 39 or less; caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.2 or less. 22
- 16 (15) Dorsal rays 12 or less. 17
- Dorsal rays 13 or more. 19
17. (16) Caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.3 or more; A. 11-14; sides with crossbars in both sexes. 21
- Caudal peduncle depth into distance from caudal base to anterior insertion of dorsal 3.2 or less; A. 9-12. 18
18. (17) Range: coastal, in fresh or brackish water, Chesapeake Bay to Texas; a black ocellus or spot between last few rays of dorsal fin of female; vertical fins never narrowly black-edged; cheek dark or coarsely speckled; both sexes vertically barred (females from Gulf Coast sometimes spotted or longitudinally streaked); see also first halves of couplets 30 and 25. 32
- Range: reported only from the lower Tennessee River drainage of Alabama and Tennessee; ocellus not present on dorsal; vertical fins often narrowly black-edged; cheek clear or coarsely speckled; vertical bars absent; males with interrupted white lines following centers of scale rows; females with fine, dark, broken lines following centers of scale rows; D. 10-11; A. 10-11; lateral-line scales about 42. *F. albolineatus*
- Range: Oklahoma to Wyoming and South Dakota; ocellus not present on dorsal; vertical fins not narrowly black-edged; cheek clear or finely speckled only immediately below eye; vertical bars absent; see also couplet 26. *F. sciadicus*
19. (16) Vertical bars absent on the sides of both sexes; males with light lines following centers of scale rows, alternating with dark lines running between scale rows, sometimes irregularly broken or dashed; females with fine, dark, dashed lines following centers of scale rows, or irregularly speckled with black; dorsal behind or over anal; A. 13-19; snout short. 20
- Vertical bars usually present on the sides of both sexes, sometimes fused into a short longitudinal band on caudal peduncle;

- dorsal before or over anal; A. 10-15; snout long..... 21
20. (2, 19) Anal rays 14-15 (95 percent separation), (13-16); scales around caudal peduncle 19-23; orange or dark flecks scattered randomly over sides of body or loosely arranged in broken, irregular, longitudinal lines; found only in Alabama River System
- F. stellifer*
- Anal rays 16 (95 percent separation), (15-19); scales around caudal peduncle 16-20; orange or dark flecks arranged in orderly parallel lines following scale rows; not found in Alabama River System..... *F. catenatus*
21. (17, 19) Found in Florida only; D. 13-20; A. 10-15; pectoral 18 to 21; lateral-line scales 49-61; scales around caudal peduncle 24-29
- F. seminolis*
- Found only in Lake Waccamaw, N. C.; D. 13-15; A. 10-12; pectoral 15 to 18; lateral-line scales 54-64; scales around caudal peduncle 19-25 (range and counts from Hubbs and Raney, 1946: 12-17)
- F. waccamensis*
- Found from South Carolina north to Maritime Provinces (*F. d. diaphanus*) and from the eastern Dakotas to western New York (*F. d. menona*), with intergrading populations between. *F. d. diaphanus*: lateral-line scales 45-49 (40-55); D. 13-14 (12-15); A. 11-12 (10-13); pectoral 16 to 17 (15 to 19). *F. d. menona*: lateral-line scales 40-44 (35-49); D. 11-13 (10-14); A. 10-11 (9-12); pectoral 14 to 15 (13 to 17). For more detailed separation of subspecies see Hubbs and Lagler (1947: 77-78), from which the above information and counts were taken..... *F. diaphanus*
22. (15) Dorsal behind (or over) anal; dorsal rays fewer than anal rays..... 23
- Dorsal before or over anal; dorsal rays more than or equal to anal rays..... 27
23. (22) Sides of body with 12-30 round spots the size of a scale or less, often arranged in two rows lying along or above the lateral line, blended in some specimens to form short, indistinct, vertical bars; scales around caudal peduncle usually 16; top of head flat or slightly concave in front of eyes; snout short and sharp; Texas to western Florida
- F. jenkinsi*
- Sides of body not spotted as above; scales around caudal peduncle usually 20; snout less sharp..... 24
24. (22) A fine dark line running from beneath eye to, or almost to, corner of mouth (usually absent in young); a thicker line on the same level on the opercle, distinct in young (sometimes blurred or absent in adults); found only in the Piedmont region of North Carolina; see couplet 27 for additional description..... *F. rathbuni*
- A fine, dark line from beneath eye to corner of mouth absent; no line on opercle, as described above; males vertically barred; females variously colored but not with dark speckling..... 25
25. (24) Cheek below eye dark or coarsely dotted; dorsal before or over anal; dorsal rays commonly more than anal rays; a dark ocellus on last few rays of dorsal in females; coastal, Chesapeake Bay to Texas; see first half of couplet 30 for additional description.... 32
- Cheek below eye clear or only finely dotted; dorsal behind (or over anal); dorsal rays commonly fewer than anal rays; ocellus on dorsal absent (except very rarely when also found on body)..... 26
26. (25) Dorsal rays 8-10; anal rays 11 (10-12); lateral-line scales 30-34; males with dark vertical bars; females with small light spots irregularly scattered on sides; both sexes occasionally occur with heavy dark blotches anywhere on body or fins; see couplet 13 for additional description..... *F. chrysolus*
- Dorsal rays 11-12 (10); anal rays 13 (12-14); lateral-line scales 28-41; both sexes plain colored or with broad, faint lateral stripe; a Plains species, from Oklahoma to Wyoming and South Dakota..... *F. sciadicus*
27. (22) A fine, dark line running from beneath eye to, or almost to, corner of mouth, usually absent in young; a thicker line at the same level on the opercle, distinct in young (sometimes blurred or absent in adults); males plain with few if any spots on body, each scale with dark outline; females with dark spots and flecks irregularly scattered on sides, rarely forming vague bars or lines; fins usually unspotted; D. 11-14; A. 10-12; pectoral 15 to 18; lateral-line scales 33-38; found in the Piedmont region of North Carolina..... *F. rathbuni*
- A fine, dark line from beneath eye to corner of mouth absent; line on opercle (as described above) also absent; males vertically barred; females variously colored..... 28
28. (27) Snout pointed, long, a little less than 2 times eye in side view (except in young), distinctly below a horizontal line through middle of eye (except in young); orbit into postorbital head length from 2.0 in small adults to 2.7 in large adults; dark vertical bars when present narrower than two-thirds the interspace; a silvery sheen on sides of young and adults of both sexes..... 29
- Snout round, short, a little over one times eye in side view, usually on a level with or above a horizontal line through middle of eye; orbit into postorbital head length from 1.5 in small adults to 2.0 in large adults; dark vertical bars in males generally broader than or equal to interspaces; bars variable in females; silvery sheen not conspicuous on sides..... 30
29. (28) Dorsal rays 14-15 (12-16); lateral-line scales 33-35 (32); adult females with one to several dark longitudinal lines on sides;

head length into standard length 3.0-3.3 (2.9) Florida to New Hampshire. *F. majalis*
 Dorsal; rays 12-13 (11-14); lateral-line scales 30-32 (33); females lack dark longitudinal lines on sides; head length into standard length 2.7-2.9 (2.7-3.1); Florida to Texas

F. similis

30. (28) Anal rays 10 (9-11); pectoral rays 17 (18) or less; lateral-line scales 34-37 (32-45); females with an ocellus or one or two black blotches on last few rays of dorsal fin, remainder of dorsal fin usually unmarked; pouch at anterior base of anal very small or lacking in females, higher on first ray of spread anal fin than on any succeeding ray, usually one-tenth length of depressed anal or less; back mottled with dark spots; all fins much shorter in both sexes; caudal fin length 5 to 6 into standard length of adults over 35 mm, 4.4 to 5.0 in young; Chesapeake Bay to Texas 32

Anal rays 11 (10-12); pectoral rays 18 (17) or more; lateral-line scales 31-34 (35); females with dorsal fin clear, no ocellus or dark blotch; easily separated by the anal pouch, which is shorter on the first ray than on the several immediately succeeding rays when the fin is spread and is often much longer than one-tenth the length of the depressed fin; upper half of body usually of uniform tone; all fins longer in both sexes and in young; caudal fin more square, length 3.5 to 4.5 into standard length in young and adults; Maritime Provinces to Texas 31

31. (30) Range: Maritime Provinces to northeastern Fla.; total mandibular pores 8; longest anal ray into head length 1.2-1.9 (mean 1.5-1.6); head length into standard length 2.9-3.7 (mean 3.2-3.4); base of dorsal into head length 1.7-2.4 (mean 1.95-2.2); (above proportions taken from 13 specimens from North Carolina, 42-75 mm standard length, mean 59.4, and 25 specimens from New York, 48-98 mm standard length, mean 68.1) *F. heteroclitus*

Range: peninsular Florida to Mexico; total mandibular pores 10; longest anal ray into head length 1.9-2.6 (mean 2.1); head length into standard length 2.8-3.3 (mean 3.0); base of dorsal into head length 2.1-3.1 (mean 2.6); (above proportions taken from 35 Florida specimens 34-105 mm standard length, mean 53.8) *F. grandis*

32. (18, 25, 30) Sides of females with numerous dark spots as large as pupil of eye, sometimes confluent into longitudinal lines, vertical bars absent; dorsal rays usually 10 (9-11); along coast from Alabama to southern Texas (Corpus Christi) *F. pulvereus*

Sides of females with numerous dark, narrow, vertical bars; spots as above absent; dorsal rays usually 11 (10-12); along coast from Chesapeake Bay to Alabama

F. confluentus

LIST OF SPECIES AND SUBSPECIES

Subgenus *Fundulus* Lacépède

Fundulus heteroclitus heteroclitus (Linnaeus)

MUMMICHOG

Until the variation in *Fundulus heteroclitus* has been adequately described, it seems best not to recognize the northern part of the species as being subspecifically distinct. The characters involved appear to be clinal and do not afford a clear separation. A detailed study of the variation in this species, *Fundulus grandis*, and the populations on Bermuda is needed.

Range: From Anticosti Island in the Gulf of St. Lawrence (Kendall, 1909: 221, 242) south along the Atlantic Coast to the Matanzas River, St. Johns County, northeastern Florida (Miller, 1955: 78). Primarily in brackish water.

Fundulus grandis grandis (Baird and Girard)

GULF KILLIFISH

Range: From the Matanzas River, St. Johns County, northeastern Florida, south along the Atlantic Coast to the Florida Keys, and north and west from there along the Gulf coast at least to Laguna de Tamiahua, Mexico (Miller, 1955: 8). Typically in brackish water.

Fundulus majalis (Walbaum)

STRIPED KILLIFISH

Range: From New Hampshire (Jackson, 1953: 192) along the Atlantic coast to the Matanzas River, St. Johns County, northeastern Florida (Miller, 1955: 9). Typically in salt or brackish water.

Fundulus similis (Baird and Girard)

LONGNOSE KILLIFISH

Range: From the Matanzas River, St. Johns County, northeastern Florida, along the Atlantic coast to Key West and along the Gulf coast at least to a lagoon 35 miles north of Tampico, Mexico (Miller, 1955: 9). Typically in salt or brackish water.

Fundulus confluentus Goode and Bean

MARSH KILLIFISH

Fundulus chaplini Fowler (1940: 8) and *Fundulus bartrami* Fowler (1941: 235-236) are synonyms, respectively, of the male and female of *Fundulus confluentus*. This may be seen by ex-

amination of Fowler's plates and original descriptions and is supported by notes taken by Dr. C. Richard Robins on the type specimens at the Academy of Natural Sciences of Philadelphia. Miller (1955: 2, 4-5) concurs and elaborates on these allocations.

Range: From Chesapeake Bay, Md., along the Atlantic coast to Key West, Fla. (Miller, 1955: 8), and along the Gulf coast to Big Lake, Gulf Shores, Baldwin County, Ala., a few miles west of the mouth of Pensacola Bay (Bailey, Winn, and Smith, 1954: 132). Typically in brackish water.

Fundulus pulvereus (Evermann)

BAYOU KILLIFISH

From the original description *Zygonectes funduloides* Evermann (1892: 85) appears to be the male of *Fundulus pulvereus*, which Evermann described from females in the same paper. It bears little resemblance to *Fundulus grandis* despite Jordan and Evermann's (1898: 2828) suggestion.

Range: From Bayou Minette at Old Spanish Fort, Baldwin County, Ala., a few miles west of the limit of the known range of *Fundulus confluentus* (Bailey, Winn, and Smith, 1954: 132), west along the Gulf coast at least to Corpus Christi, Tex. (Evermann, 1892: 85). Typically in brackish water.

Subgenus **Fontinus** Jordan and Evermann

Fundulus diaphanus diaphanus (Le Sueur)

BANDED KILLIFISH

The variation in this species has been summarized by Shapiro in Hubbs and Lagler (1947: 77). Hybrids between this subspecies and *Fundulus heteroclitus* occur rarely (Hubbs, Walker, and Johnson, 1943: 3).

Range: From Waverly Mills, S. C. (Hubbs and Raney, 1946: 14) "north to the Maritime Provinces; west through the eastern parts of Pennsylvania and New York including the Lake Champlain basin; locally in the Allegheny River System of Pennsylvania (doubtless through introduction)" (Hubbs and Lagler, 1974: 78). Typically in fresh water but occasionally in brackish water.

Fundulus diaphanus menona Jordan and Copeland

BANDED KILLIFISH

Range: "From the eastern parts of the Dakotas through Minnesota, Wisconsin and Michigan

and through the northern parts of Illinois, Indiana, and Ohio to southern Ontario and westernmost New York. Intergrading with *F. d. diaphanus* in the Lake Ontario and St. Lawrence basins (as determined by Sydney Shapiro)" (Hubbs and Lagler, 1974: 78). Found in fresh water.

Fundulus waccamensis Hubbs and Raney

WACCAMAW KILLIFISH

This species is closely related to *Fundulus d. diaphanus*.

Range: Known only from Lake Waccamaw, N. C. (Hubbs and Raney, 1946: 14; Frey, 1951: 22). Fresh water.

Fundulus seminolis (Girard)

SEMINOLE KILLIFISH

Range: Peninsular Florida in Lake, Sumter, Okeechobee, DeSoto, Osceola, Charlotte, Polk, and Lee Counties (various Cornell collections) and Wakulla County (University of Florida Collection no. 103). Fresh and brackish water.

Subgenus **Xenisma** Jordan

Fundulus catenatus (Storer)

NORTHERN STUDDFISH

Range: Headwaters of the Tennessee and Cumberland Rivers, and the Green River, in Kentucky, Tennessee, Virginia, and Alabama; in clear streams of the Ozarks in Kansas, Arkansas, and Missouri; in tributaries of the Red River in southwestern Arkansas; in the Homochitto River, Miss.; and in the upper part of the East Fork of White River, Ind.; in moderate to swift, clear streams (Miller, 1955: 9).

Fundulus stellifer (Jordan)

SOUTHERN STUDDFISH

This species is closely related to *Fundulus catenatus*.

Range: Known only from the Alabama River System in Georgia and Alabama. Cornell material is from tributaries of the Etowah and Oostanaula Rivers of Georgia and the Talladega River in Alabama. Habitat similar to that of *F. catenatus*.

Fundulus albolineatus Gilbert

WHITELINE TOPMINNOW

Range: Known only from clear, cold springs and spring-fed creeks in the lower Tennessee River System of Alabama and Tennessee (Miller, 1955: 9). Hubbs's (1926: 11) mention of *albo-*

lineatus from the "Alabama basin" gives no details and is probably an error.

Fundulus rathbuni Jordan and Meek

SPECKLED KILLIFISH

The intraspecific variation, subgeneric affiliations, and synonymy of this species have been treated by Brown (1955).

Range: Streams of the Piedmont region of North Carolina in the Roanoke, Cape Fear, Neuse, and Pee Dee River systems (Brown, 1955: 212).

Subgenus ***Plancterus*** Garman

Fundulus zebrinus Jordan and Gilbert

SOUTHWESTERN PLAINS KILLIFISH

Range: Shallow, open streams in the upper portions of the Brazos, Colorado, and Pecos drainages of Texas and New Mexico, and from saline waters on the Llano Estacado of northwestern Texas (Miller, 1955: 10-11).

Fundulus kansae Garman

CENTRAL PLAINS KILLIFISH

This species has hybridized with *Fundulus sciadicus* (Hubbs, Walker, and Johnson, 1943: 15).

Range: In shallow streams of the Great Plains from Wyoming (Simon, 1946: 96) and South Dakota (where possibly introduced) south to the Red River in northern Texas and the Arkansas River in New Mexico, east to Missouri (Miller, 1955: 11-12).

Subgenus ***Zygonectes*** Agassiz

Section A

Fundulus luciae (Baird)

SPOTFIN KILLIFISH

Range: Salt marshes from Long Island and New Jersey, where rare (Nichols and Breder, 1927: 55; Greeley, 1939: 84), south to North Carolina (Hildebrand, 1941: 255).

Fundulus jenkinsi (Evermann)

SALTMARSH TOPMINNOW

Range: Salt marshes from Galveston Bay, Tex., to the mouth of the Escambia River, Fla. (Bailey, Winn, and Smith, 1954: 133).

Fundulus cingulatus Valenciennes

BANDED TOPMINNOW

Fundulus cingulatus superficially resembles *Fundulus chrysotus* and *Fundulus luciae*, with

which it has been confused in the literature. For a description of the variation in the characters distinguishing *cingulatus* from *chrysotus* see Brown (1956).

Range: In lowland, fresh-water swamps from the region of Okefinokee Swamp in southwestern Georgia south in Florida to the Tamiami Canal and Fort Myers (Brown, 1956), and west to the Escambia River, Ala. (Bailey, Winn, and Smith, 1954: 132).

Fundulus chrysotus (Günther)

GOLDEN TOPMINNOW

Range: In lowland, freshwater swamps from South Carolina to the Tamiami Canal in southern Florida (Brown, 1956), west along the Gulf coast to eastern Texas, and north to southern Missouri and Tennessee (no records from Oklahoma) (Miller, 1955: 10).

Fundulus sciadicus Cope

PLAINS TOPMINNOW

Range: Streams of the Great Plains in the Missouri, Platte, and Arkansas River systems from South Dakota (Churchill and Over, 1938: 62-63), eastern Wyoming (Simon, 1946: 96), and eastern Colorado (Beckman, 1952: 73), east and south to Iowa (Harlan and Speaker, 1951: 137), Missouri (Meek, 1891: 122), and Oklahoma (Hubbs and Ortenburger, 1929: 98).

Section B

Fundulus notti notti (Agassiz)

STARHEAD TOPMINNOW

For a discussion of the variation in *Fundulus notti* see Brown (in press). Range: Gulf coast river systems from the New River of western Florida to Louisiana and eastern Texas (where subspecies uncertain) (Brown, in press).

Fundulus notti dispar (Agassiz)

STARHEAD TOPMINNOW

The range of this subspecies where it meets that of *F. n. notti* remains to be adequately determined.

Range: Lowlands from Iowa, southern Wisconsin, and the Lake Michigan drainage of Michigan and Indiana south to northeastern Arkansas and western Tennessee (Hubbs and Lagler, 1947: 78).

Fundulus notti lineolatus (Agassiz)

STARHEAD TOPMINNOW

Range: Bottomlands from Isle of Wight and Nansemond Counties (Cornell specimens) in southeastern Virginia south along the Atlantic Coastal Plain to central peninsular Florida and west along the Gulf Coastal Plain to the Ocheekonee River of Georgia and western Florida (Brown, in press).

Fundulus notatus (Rafinesque)

BLACKSTRIPE TOPMINNOW

For details on variation and distinguishing characters of this species and *Fundulus olivaceus* see Brown (1956).

Range: In streams and lakes from Mitchell and Grundy Counties of northeastern Iowa, southeastern Wisconsin (both sides of the divide), southern Michigan, and the prairie regions of western and central Ohio south to Kentucky, the Duck River of Tennessee, the Gulf drainages from the Tombigbee River System of Alabama to the Guadalupe River System of Texas, and west to Kay, Creek, and Johnston Counties of eastern Oklahoma, and Kansas (Brown, 1956: 132).

Fundulus olivaceus (Agassiz)

BLACKSPOTTED TOPMINNOW

In view of the following statement about the type of *Fundulus balboae* Fowler by Hubbs (1931: 6) I feel that this nominal species should be allocated to the synonymy of *Fundulus olivaceus* rather than that of *Fundulus notatus*. "Traces are evident of the black spots on the dorsal fin and upper part of the body, which are conspicuous in many southern specimens of *F. notatus*." In 1931 when Hubbs wrote the above, it was thought that the characters mentioned, which are now recognized as those of *F. olivaceus*, were merely color variations of *F. notatus*.

Range: In streams and lakes from the Chatahoochee River System of Alabama and Florida and the Clinch River System of Tennessee west to Texas and the Arkansas and Red River systems of eastern Oklahoma, and north to Morgan County, Missouri, western Kentucky and Tennessee, and the Mississippi and Ohio drainages of Illinois (Brown, 1956: 127-128; Miller, 1955: 10).

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NEWS OF MEMBERS

WALLACE R. BRODE has been elected president-elect of the American Association for the Advancement of Science. WILLIAM W. RUBEY and ALAN T. WATERMAN are new members of the AAAS board of directors. Other officers and committee members include C. B. WATTS, E. RAYMOND HALL, J. HOWARD McMILLEN, KARL S. QUISENBERRY, A. NELSON SAYRE, J. FRANKLIN YEAGER, and WARD PIGMAN.

LEO A. WALL, National Bureau of Standards, was one of five young Government scientists honored as 1956 winners of the Arthur S. Flemming Award.

WILLIAM D. APPEL, National Bureau of Standards, has been honored by the American Society for Testing Materials for outstanding achievement in research on fibers. He was awarded the Harold De Witt Smith medal.

FRANCIS O. RICE, head of the chemistry department of the Catholic University, has been given the 1957 Hillebrand Award of the Washington section of the American Chemical Society. The award is in recognition of his pioneer work in the field of free radical research.

LEWIS M. BRANSCOMB, National Bureau of Standards, has been awarded a Rockefeller Public Service Award to study the physics of

negative ions and low-energy ionic collisions at University College, London, for a year.

DEANE B. JUDD, National Bureau of Standards, was awarded the Inter-Society Color Council's Godlove Award for outstanding contributions to the knowledge of color in science, art, and industry. The award is symbolized by a prism enclosing a gold diffraction grating.

FRANCIS E. WASHER, National Bureau of Standards, was given the Talbert Abrams Award of the American Society of Photogrammetry, for authorship and scientific developments in photogrammetry.

BENO GUTENBERG, director of the Seismological Laboratory of the California Institute of Technology, has been awarded the Emil Wiechert medal of the German Geophysical Association in appreciation of his accomplishments in seismology and in the investigation of the earth's structure. This is the second award of the medal, founded in 1955, for outstanding accomplishment in geophysics.

The Phi Delta Epsilon Fraternity has presented its annual award of merit to JOSEPH KAPLAN, professor of physics at the University of California, Los Angeles, who is at present serving as coordinator of the American contributions to the International Geophysical Year.